PN-ABC-883

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D C 20523

DATE: 12/21/88

MEMORANDUM

TO: AID/PPC/CDIE/DI, room 209 SA-18

FROM: AID/SCI, Victoria Osc

SUBJECT: Transmittal of AID/SCI Progress Report(s)

Attached for permanent retention/proper disposition is the following:

AID/SCI Progress Report No. C7-052
PR final print

Attachment

Title: Bioproduction of Modified Atmospheres in Small Grain-Storage Containers for Insect Control

Grant No. DPE-5544-G-SS-7024-00.

A Progress Report for the First Period.

C7-052

Submitted by:

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and

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Title: Bioproduction of Modified Atmospheres in Small Grain-Storage Containers for Insect Control

N. Paster, M. Calderon and Mazal Menasherov - ARO, Israel
M. Mora - CIGRAS, Costa Rica

Progress Report No. 1 (July 1988)

A. Israel

During the first period of this study we concentrated on testing the fitness of various materials to yield high CO_2 levels and thus be suitable to serve as biogenerators. The following were tested: damaged corn grains, wheat bran, and peanut shells - which are known to be unused agricultural waste products.

1. CO_2 production

The biogenerator installation: Plastic cans (ca 2.0 l. volume, 20cm height and 12cm inner diameter) were used throughout the studies. The cans were filled with 200 g of either bran or shells at 3 different levels of moisture content (mc). The mc levels of the bran were 13.7, 17.6 and 24%, and those of the shells were 9, 16.4 and 25.7%. The cans were closed but not completely airtight. In the case of the corn grains (25%cm) - 500 ml glass containers were used. Following the first series of trials we noticed water accumulation at the bottom of the plastic cans and therefore a wire mesh was introduced into each can 5 cm above the base. Two plastic tubes were connected to each can: one to allow CO_2 migration from the biogenerator to the grain bin, and the second to allow the removal of excess water from the biogenerator.

Measurement of CO_2 and O_2 levels:
The CO_2 level was measured using a Portable Gas-Analyzer (Riken Infrared Gas-Analyzer Model RI-550A), and the O_2 level, using a

portable oxygen detector (Herrmann - Morits, Oxymeter type HM 18). In some cases, the composition of air samples taken from the biogenerators was analyzed using a gas chromatograph. For the gas chromatography analysis an air sample (ca 5 ml) was withdrawn from the plastic tubing (which was closed before using an airtight syringe) and then injected into the gas chromatography apparatus. All the trials were carried out in duplicate in a constant-temperature room ($26\pm1^{\circ}C$).

Results

CO_2 production by the substrates tested is shown in Figs. 1-3. Corn grain produced the highest levels of CO_2, with a peak production of ca 60-70% recorded from 300 g of corn. The CO_2 levels recorded for wheat bran and peanut shells were lower (10-13%). However, with bran (24% mc), the high CO_2 level produced was maintained throughout the 24 days storage period, as compared with the peanut shells which produced a high CO_2 level which dropped gradually from 13% to 2% (in the 25.7% mc). With both of these substrates, increasing the mc resulted in higher CO_2 levels. Based on these results, we plan to continue our studies with wheat bran and corn grains and to use them as substrates in biogenerators which will be connected to grain bins.

2. Small-scale studies of CO_2 migration from a biogenerator

With the aim of determining CO_2 migration from a biogenerator, another series of trials was undertaken, in which the experimental system comprised an upper glass container (500 ml in volume) filled with 300 g of wet corn (25% mc) (the biogenerator) and a lower container, which was either empty or filled with dry corn (13.5% mc). The distance between the containers was 20 cm, which was bridged by plastic tubing inserted into the bottom of each container. The containers were closed but not sealed hermetically, in order to avoid anaerobic conditions. CO_2 and O_2 contents were measured daily in both of the containers, using the gas chromatography system.

Results and Discussion

The corn grains yielded high levels of CO_2, and within 2 days reached ca 20%, as measured in the biogenerator (Fig. 4-5). The CO_2 accumulated further, reaching a peak level of 60-70% (after 10-13 days) followed by a sharp decrease recorded until the 32nd day of storage. In all cases the CO_2 increase was concomitant with a marked reduction in the O_2 level. High levels of CO_2 were recorded also in the lower storage container, whether empty or filled with dry corn. In both cases the rate of increase in CO_2 in the lower container paralleled that recorded in the upper biogenerator. However, the peak level was 40-50%. A marked decrease in the O_2 level was recorded as well. The concentration of O_2 was ca 2% (already after 4 days) in the lower container filled with grain, whereas when the lower container was empty - the O_2 decreased gradually from 9% to 2%.

The data indicate that CO_2 migrated from the upper biogenerator to a lower container. The gas accumulated to levels which are known to be undesirable for insects. These high CO_2 levels, along with the low O_2 concentrations, create an atmosphere which is lethal for storage insects.

The above studies were undertaken on a small scale. Studies on larger scale with different types of substrates are planned for the second period, and within the frame work of these studies the rate of CO_2 accumulation. O_2 decrease in 25 kg capacity bins as well as the effect of the atmospheres created by the biogenerator on the mortality of storage insects will be studied in vivo.

Fig. 1 - CO_2 production by corn grains (25% mc) stored in a 500-ml glass container.

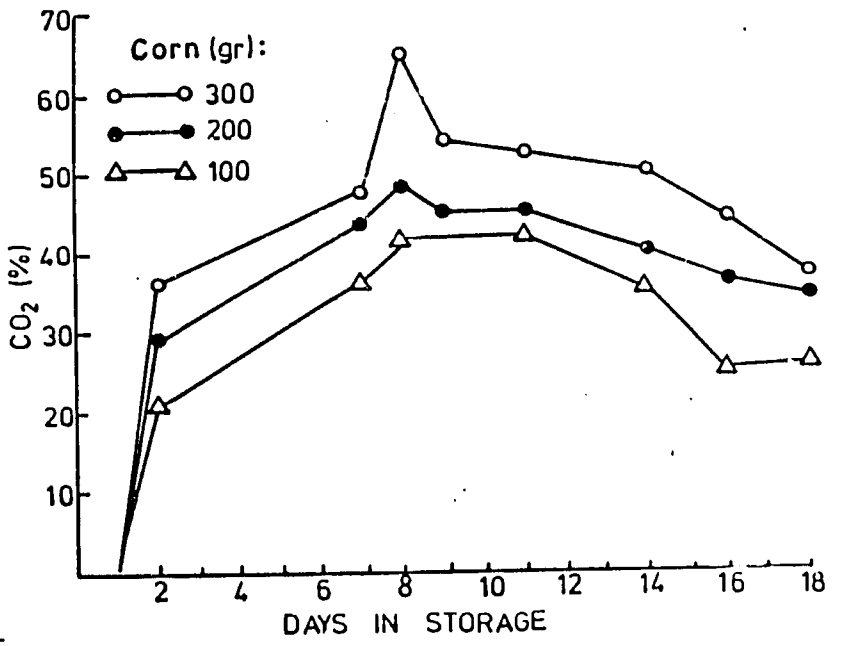


Fig. 2 - CO_2 production by wheat bran stored in plastic cans (biogenerators) at different moisture content (mc) levels.

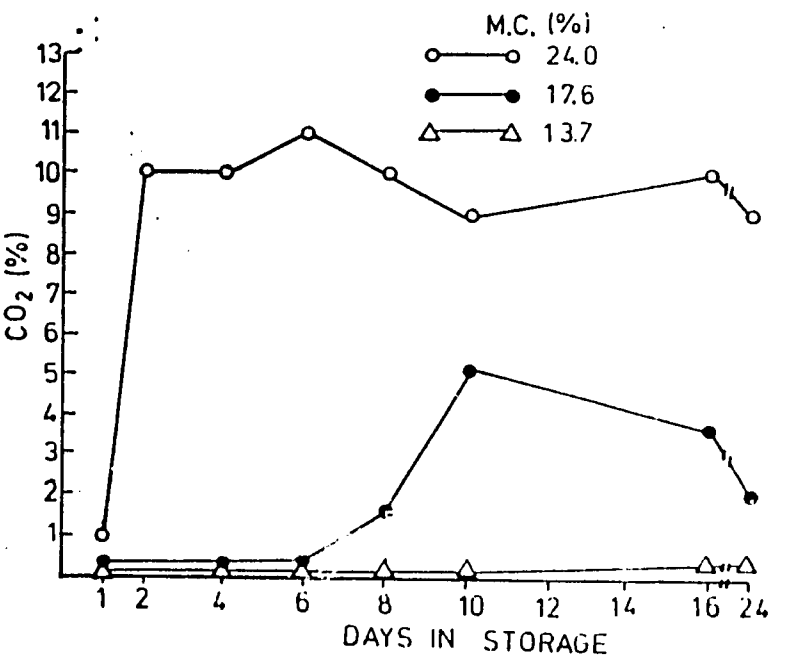


Fig. 3 - CO_2 production by peanut shells stored in plastic cans (biogenerators) at different moisture content (mc) levels.

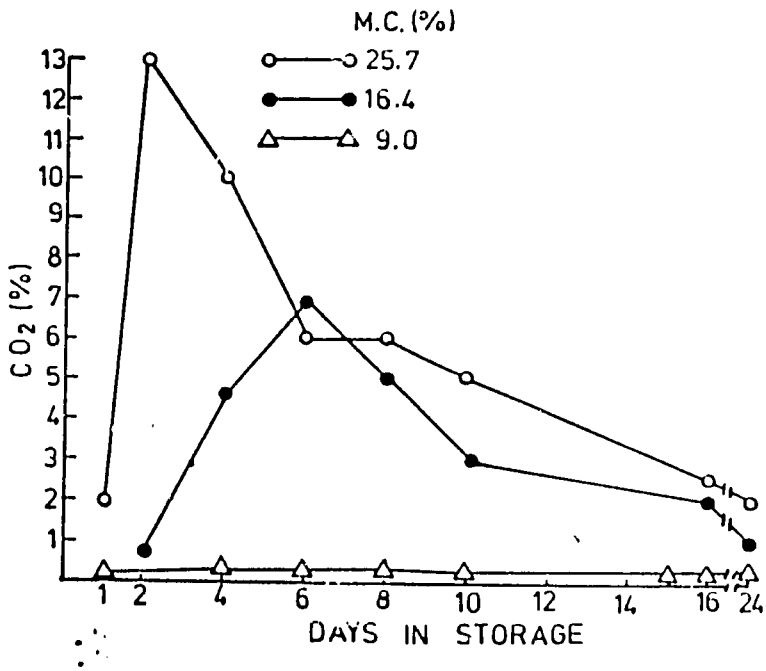


Fig. 4 - CO_2 and O_2 levels in the biogenerator and lower container filled with corn grain, during the course of the trial.

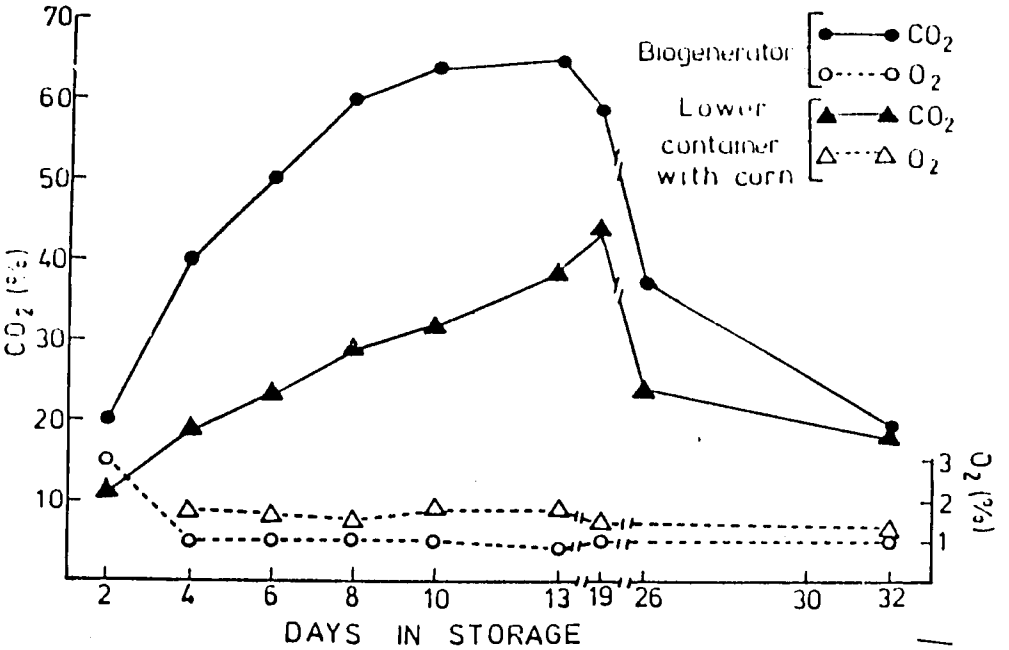
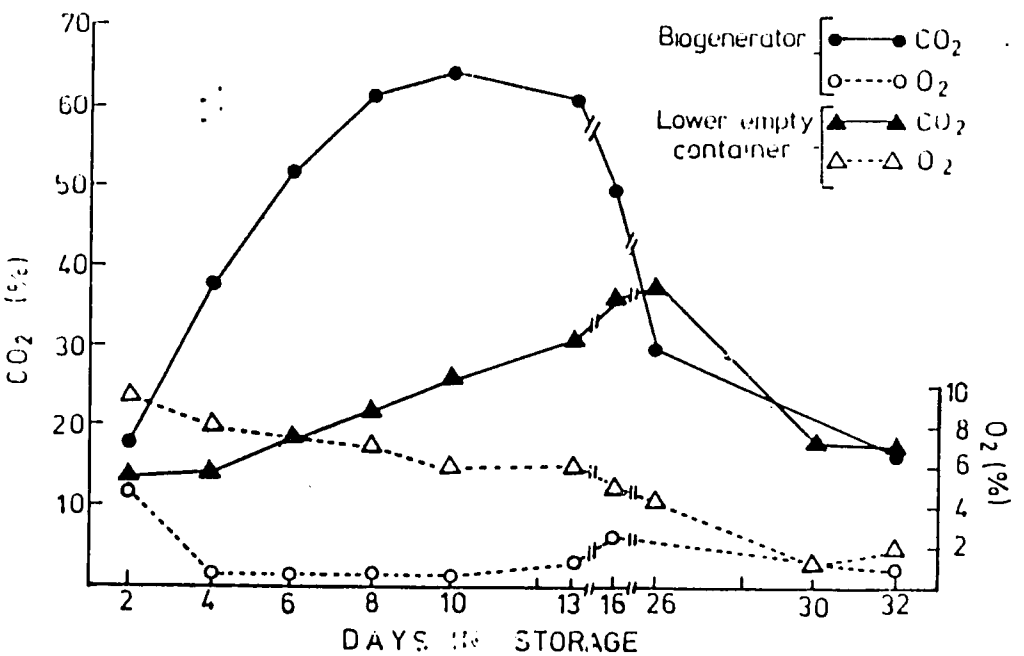


Fig. 5 - CO_2 and O_2 levels in the upper biogenerator and lower, empty container, during the course of the trial.



COSTA- RICA:

FOR Dr. Nachman Paster, Institute for Tech. & Storage Agr. Products
FROM Dr. Miguel Mora, CIGRAS, COSTA RICA

INITIAL RESULTS OF PROJECT "INSECT CONTROL WITH CO2"
ARO, ISRAEL AND CIGRAS, COSTA RICA PROJECT.

Results of preliminary test on CO2 generation through fermentation of various materials. Tests done at ambient temperature (23 ± 2 C)
"IS VERY IMPORTANT TO READ NOTES RELATED TO THIS RESULTS"

MATERIAL	GAS VOL. IN COLLECTOR	GAS COMPOSITION WITHIN:				TREATMENT OF MATERIAL WITH WATER
		COLLECTOR		GENERATOR		
	(ml/week	% CO2	% O2	% CO2	% O2	
Damaged corn	1075	5	19	41	6	Wetted. (W) 1 kg. (30 % c.h.).
Damaged corn	600	7	*	50	*	Immerged (I) 1 kg in 750 ml.
Damaged corn	2300	12	21	42	*	Immerged (I) 1 kg in 1800 ml.
Corn leaves	300	2	*	20	3	Grossly cut (W) 500 g in 1 l.
Corn leaves	1500	4	18	20	0	Finely cut (I) 500 g in 1.5 l.
Pasture	*	*	*	30	0	Grossly cut (I) 500 g en 2 l
Pasture	*	*	*	30	0	Grossly cut (W) 82% c.h.
Pasture	1000	3	*	39	0	Finely cut (I) 500 g in 2 l
Pasture	1300	4	19	32	0	Finely cut (W) 87 % c.h.
Banana leaves	2150	6	17	33	6	Grossly cut 500 g in 1 l
Banana leaves	1950	9	18	74	*	Finely cut 500 g in 1 l

* INSUFFICIENT QUANTITY FOR MEASUREMENT